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ABSTRACT

This project developed and evaluated a series of interactive study modules for students taking a course in Analysis of Variance (ANOVA) techniques using the IBM Interactive Instructional System (IIS) software. Exercises were general enough to be applicable across a variety of research areas. The computer assisted instruction (CAI) approach was particularly appropriate for this type of material because of the hierarchical nature of the steps involved in ANOVA procedures. Graduate students enrolled in advanced statistical methods were required to complete each interactive lesson as they progressed through the course. Four classes over four years of implementation were evaluated by midterm and final unit exams for the course, course evaluation, and module evaluations. In terms of satisfaction and effectiveness, students ranked modules second only to the class lectures as a whole and far above the textbook and independent practice. There were significant increases in unit examination performance after module implementation. Initial responses of anxiety and apprehension concerning the computer environment yielded as student became familiar with the system. (Author/RL)

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Interactive Study Lessons to Complement ANOVA

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ABSTRACT

This project developed and evaluated a series of interactive study modules for students taking a course in Analysis of Variance (ANOVA) techniques using the IBM Interactive Instructional System (IIS) software. Exercises are general enough to be applicable across a variety of research areas. The CAI approach is particularly appropriate for this type of material because of the hierarchial nature of the steps involved in ANOVA procedures. Four classes over four years of implementation were evaluated. Students responded positively to the interactive lessons and there were significant increases in unit examination performance as compared with pre-implementation classes. The adult student appears to fear and be apprehensive of the interactive mode initially but becomes accepting through usage.

Interactive Study Lessons to Complement ANOVA

The major goals of this project were the development and evaluation of a series of interactive study modules to be used as an adjunct to regular classroom instruction by students taking a course in analysis of variance procedures. The course starts with the simplest one-way analysis of variance procedure and progresses systematically to complex, sophisticated techniques. Textbooks in the area generally present adequate coverage of theory and formulas but are not usually particularly good at handling practice exercises. Typically, each complete analysis of variance procedure (e.g., one-way ANOVA) consists of many hierarchial steps which are dependent upon each other. The problem encountered by the learner is that the few exercises then appearing in texts inevitably consist of extended sequences of steps in which a mistake at any step along the way causes the final answer to be erroneous. If the student fails to obtain a correct arswer, one does not generally know at which step the error occurred. This is very frustrating to the student and makes it extremely difficult for students to find the source of their incorrect answers.

Interactive study with computer modules is an especially effective way of handling the sequential dependence of steps characteristic of hierarchial problem solutions. The student is able to address each step individually, tackling each in turn, thus receiving immediate feedback at each step. Since feedback occurs at each step, the student receives information about the success or failure of methods immediately, allowing one to concentrate on particular areas of weakness rather than fumbling around wasting considerable time and energy trying to find the location of errors after one has completed the entire problem and having to redo portions of problems which depended on the erroneous result.

These obstacles constitute serious impediments to learning and are not confined to analysis of variance, but are characteristic of a broad variety of basic cogitive skills--especially those of mathematics and science curriculums. The removal of such obstacles has assumed greater priority in recent years given increasing school discipline problems, "teacher burn-out" and declining achievement test scores. These issues have also, up till now, been relatively difficult, if not impossible, to closely address within the context of regular classroom instruction. Closest approximations have probably occurred within the context of an apprenticeship or through the caring assistance of a private tutor. Occasionally, such individualized instruction has been available for large groups of students, but generally such has not been the case for students of public educational institutions.

Theoretical Framework

Computer assisted instruction (CAI) would seem to provide a means for removing these sorts of obstacles. The interactive mode of learning has been likened to having one's own private tutor (Skinner, 1968) and may potentially offer the most effective adjunct to regular classroom instruction since the invention of the printing press. Some of the presumed benefits of CAI are those associated more generally with programmed instruction (i.e., logical sequence of small steps, immediate feedback, frequent active responding, and starting at one's own level and proceding at one's own pace [see Sulzer & Mayer, 1972]). While, in addition, the computer adds an extra ingredient--external discipline, (see Dean, 1977)--in addition to the fact that the computer does not become impatient as instructors are sometimes prone to do when the student fails to grasp a concept as rapidly as expected.

Gorden (1971) and Rosenshine and Furst (1971) have enumerated some of the attributes of an effective learning environment. Among them are: (a)

frequent and immediate feedback to the pupils; (b) tutorial relationships; (c) individualized pacing; (d) individualized programming; (e) clarity of presentation; (f) variability in activities; (g) motivation; (h) task or achievement oriented instruction; and (i) student opportunity to learn material to criterion. It seems clear that CAI provides the capability to offer perhaps the closest approximation to these ideals, within the context of public education, of any instructional aid yet devised. It was against the backdrop of these considerations that each interactive module was initiated and developed according to a specific format which might be referred to as symbolic participant modeling, (see Bandura, 1977).

Modules

Four independent modules were written using IBM IIS software to complement four specific ANOVA designs addressed in the class (Simple Randomized Design, Completely Randomized Block Design, Two Factor Fixed Effects, Mixed Model). The interactive module programs are implemented and delivered through hard copy terminals so that students may review data and formulas while working through the modules and take the results of their efforts home with them for study.

The basic design of each module includes three parts, (1) Explanation, (2) Example, (3) Practice. First, in the Explanation phase, a summary of the forthcoming activities is presented as an advance organizer. This phase presents the theoretical underpinnings and basic mathematical formulas for each design in a brief, yet thorough, section. The Example section follows, showing a realistic educational research problem, worked step-by-step. The realistic example provides a symbolic model of the intellectual skills to be learned. Finally, the interactive program (Practice Section) for the appropriate ANOVA design is presented. It begins by presenting the data for a

second experimental research problem of the same design classification. At this point, the user receives frequent opportunity to interact with the computer, by supplying responses generally in a free format communication method.

The program causes the computer to respond to errors which have been anticipated or incorrect answers which indicate prevalent misconceptions with comments on the reasons for this kind of error and hints on how next to proceed. Computer responses are designed to help the student avoid making the same errors again (e.g., mistaking the sum of squares between groups for the sum of squares within groups in the one way analysis of variance). The computer responds to successive incorrect answers with progressively more elaborate hints. With each successive attempt the feedback becomes more and more explicit, eventually providing the required correct answer. Accuracy feedback and verbal reinforcement are provided and varies with the degree of difficulty of the question and the success of the student. If a student achieves the correct answer to a difficult question on the first try, the response may be, for example, "Fantastic--Very Good!" However, if a student requires many attempts at the answer and therefore is given many levels of feedback in the attempt to determine the correct answer, the response may be, "That's right; now let's proceed." The modules, furthermore, were programmed to tolerate rounding errors. Responses were always supportive, modeling the educational comments of a patient and knowledgeable tutor.

METHOD

Subjects

Students in Advanced Statistical Methods are graduate students from many areas of education in a large midwestern university. Many of the students

have had little prior computer experience and none had prior interactive lessons with the computer. Students participating in the study were enrolled during the fall offerings of the course over a period of four successive years, (1977, 1978, 1979, 1980), with class sizes of 30, 28, 37 and 35 respectively. The 1977, pre-implementation class, served as the control.

Procedure

Students enrolled in Advanced Statistical Methods are required to complete each interactive lesson as they progress through the course. Students use the interactive modules as an adjunct to regular classroom instruction continually during the semester since the lessons complement each instructional section of the course. Faculty and students are able to access the modules throughout the year to facilitate review. Sources of data include midterm and final unit exams for the course, course evaluations and module evaluations.

Results

Significant differences were found among the four classes on both the midterm and the final examinations (midterm $F = 10.09$, $df = 3,126$, $p < .001$; final $F = 5.19$, $df = 3,126$, $p < .003$). Means, standard deviations and results of statistical tests are presented in Table 1. One-tailed Dunnett comparisons on both the midterm and final unit examinations were significant ($p < .05$) for the last two years of post-implementation versus the pre-implementation control class.

Students in the post-implementation classes reported strong positive evaluations of the modules and felt that they presented a fundamental and necessary learning experience for the course. Student attitudes were gathered in 1978 on an end of one year evaluation by an oral addendum to the standard course evaluation instrument, asking students to make specific

comments in a free format on their experiences with the CAI modules. The responses were then strongly positive, noting a personal belief that their knowledge had increased and requesting availability of the modules outside of class. In the formal 1979 and 1980 evaluations, recorded on specially prepared evaluation forms, the CAI modules were ranked as one of the outstanding class features. A total of 100 evaluation forms for the four modules were voluntarily completed by students during the 1979 and 1980 academic years. Students were asked to rank various aspects of the course, (lectures as a whole, lectures for the part of the course in the module, the CAI modules, working similar problems independently, and the textbook), in terms of satisfaction and effectiveness. On both, modules were ranked second only to the class lectures as a whole and ranked far above the textbook and independent practice. Furthermore, of 59 completed evaluations for the fall 1980 semester, there were only two negative responses on the five point Likert type item concerning overall experience with the modules. Module usage ran high, students continued to use the modules throughout the semester and all modules were used. Upon student request, the availability of the modules was extended into evening and weekend hours. As was to be expected, module use was especially heavy prior to examinations. Initial responses of anxiety and apprehension concerning the computer environment yielded as students became familiar with the system.

DISCUSSION

The modules appear to be a particularly appropriate and effective adjunct to regular classroom instruction as indicated by the statistically and practically significant improvements in student examination performance in the latter two years of program implementation. The pilot implementation of the

CAI program during the first year (1978) was a time of debugging, try-out and testing and for that reason might be expected to be less effective than subsequent implementations of the modules. The fact that students' voluntary evaluations of the modules were quite positive in terms of overall experience, and second only to the lectures in terms of satisfaction and effectiveness, provides additional support regarding the value of the modules for the learning experience.

Study exercises developed for the project are generalizable to a variety of research areas so that students taking courses involving Analysis of Variance procedures in a broad variety of other areas can use the interactive modules to enhance their statistical skills. Often faculty members and advanced graduate students require a refresher lesson or two in Analysis of Variance for a specific research project or comprehensive exams. The lessons can facilitate this review by directing the person through the ANOVA procedures appropriate to their research interests. Since feedback is available at each step, weak areas can be identified and strengthened by the tutorial material presented.

References

Bandura, A. Social Learning Theory, Englewood Cliffs: Prentice-Hall, Inc., 1977.

Dean, P. M. Why CBI? An examination of the case for computer-based instruction. Journal of Computer-Based Instruction, August 1977, 4, 1-7.

Gorden, J. I. Utilizing available information from compensatory education and surveys. Final Report, Office of Education, 1971.

Rosenshine, B., & Furst, J. Current and future research on teacher performance criteria. In B. W. Smith (Ed.) Research on Teacher Education: A Symposium. Englewood Cliffs: Prentice-Hall, 1971.

Skinner, B. F. The Technology of Teaching. New York: Appleton-Century-Crofts, 1968.

Sulzer, B., & Mayer, G. R. Behavior Modification Procedures for School Personnel. New York: Holt, Rinehart and Winston, 1972.

Table 1

PERFORMANCE on UNIT EXAMS by

1977, 1978, 1979 & 1980 ANALYSIS of VARIANCE STUDENTS

		EXAM			
		1		2	
Year	n	x	sd	x	sd
1977 (Control)	30	19.4	2.7	17.1	4.0
1978 (Experimental # 1)	28	19.6	2.8	16.4	2.5
1979 (Experimental # 2)	37	23.3	2.8	18.9	3.15
1980 (Experimental #3)	35	22.2	4.9	19.1	3.31